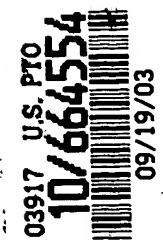


S P E C I F I C A T I O N

Docket No. **SILA0002**



TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, **Gregory Fyke**, a citizen of Canada, **Scott Woodford**, **James Nohrden**, and **Ramin Poorfard**, citizens of the United States of America, all residing in the State of Texas, have invented new and useful improvements in an

INTEGRATED RECEIVER DECODER FOR RECEIVING DIGITALLY MODULATED SIGNALS FROM A SATELLITE

of which the following is a specification:

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to receivers in general, and in particular to satellite receivers. Still more particularly, the present invention relates to a satellite receiver for receiving digitally modulated broadcast signals from a satellite.

2. Description of the Related Art

In general, digital television signals are digitally modulated when broadcast over a digital satellite communication system using phase-shift keyed modulation schemes. The digital satellite communication system typically employs a ground-based transmitter that beams an uplink signal to a satellite positioned in a geosynchronous orbit. In turn, the satellite relays the signal back to various ground-based receivers. Such digital satellite communication system permits a household (or business) subscribing to a satellite television service to receive audio and video signals directly from the satellite by means of a directional receiver antenna that is affixed to the roof or an external wall of the subscriber's residence. A directional receiver antenna constructed to receive satellite signals typically includes a dish-shaped reflector that has a feed support arm protruding outward from the front surface of the reflector. The feed support arm supports an assembly in the form of a low-noise block (LNB) amplifier having an integrated LNB feed. The reflector collects and focuses satellite signals onto the LNB feed.

The satellite signals are typically received at Ku-band or C-band. The received satellite signals are first amplified and then downshifted to a predetermined frequency band, typically in the L-band, between the range of 950 MHz and 2150 MHz. The downshifting function is typically performed within the LNB. The satellite signals are then sent via a coaxial cable to a set-top box unit located adjacent to the subscriber's

1 television. The satellite signal received at the set-top box maybe further downshifted to a
2 predetermined intermediate frequency for amplification, bandpass filtering to eliminate
3 adjacent channels and other functions such as automatic gain control, etc., with a
4 subsequent or second down conversion to baseband and recovery of the phase-shift keyed
5 modulated data.

6
7 The present disclosure provides an improved satellite receiver for receiving
8 digitally modulated broadcast signals from a satellite.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of the present invention, a receiver for receiving digitally modulated broadcast signals from a satellite includes a tuner, a demodulator, a low-noise block (LNB) controller, a voltage controller and a voltage selector implemented within a single monolithic integrated circuit device. The tuner amplifies and filters satellite signals received from a directional receiver antenna. The demodulator, which is coupled to the tuner, demodulates and decodes the received satellite signals. The LNB controller generates and detects a modulated tone to facilitate communications between the receiver and an LNB feed attached to the directional receiver antenna. The voltage selector directs the voltage controller to provide a control signal for controlling a power transistor to generate a variable voltage to the LNB feed attached to the directional receiver antenna.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a digital satellite broadcasting system to which a receiver in accordance with a preferred embodiment of the present invention is applicable;

Figure 2 is a conceptual block diagram of a satellite broadcasting receiver, in accordance with a preferred embodiment of the present invention;

Figure 3 is a block diagram of an LNB supply implemented by a DC-DC converter, according to the prior art;

Figure 4 is a functional block diagram of a receiving module of a satellite broadcasting receiver, in accordance with a preferred embodiment of the present invention; and

Figure 5 is a circuit diagram of the current sensor and the voltage sensor from Figure 4, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings and in particular to Figure 1, there is depicted a block diagram of a digital satellite broadcasting system to which a receiver in accordance with a preferred embodiment of the present invention is applicable. As shown, a digital satellite broadcasting system 10 includes a satellite broadcasting station 11 having a broadcasting antenna 12 and a broadcasting satellite 13. In digital satellite broadcasting system 10, various television programs furnished by a program purveyor are encoded by a Motion Pictures Expert Group (MPEG) encoder (not shown) to form an MPEG transport stream (MPEG-TS). After being modulated for satellite broadcasting, the MPEG-TS is transmitted to broadcasting satellite 13 from satellite broadcasting station 11 via broadcasting antenna 12. In addition to receiving MPEG-TS, broadcasting satellite 13 is also configured for retransmission of the received MPEG-TS to satellite broadcasting receivers, such as a satellite broadcasting receiver 14 that is installed in the premise of a satellite television service subscriber.

Satellite broadcasting receiver 14 receives modulated satellite signals via a directional receiver antenna 15 that is constructed to receive modulated satellite signals. Preferably, directional receiver antenna 15 includes a dish-shaped reflector 17 that has a feed support arm protruding outward from the front surface of the reflector. The feed support arm supports an assembly in the form of a low-noise block (LNB) amplifier having an integrated LNB feed 16. Reflector 17 collects and focuses modulated satellite signals onto LNB feed 16.

Satellite broadcasting receiver 14, which is also known as an integrated receiver and decoder (IRD) or a set-top box (STB), acts as a reception terminal for receiving modulated satellite signals from directional receiver antenna 15. The modulated satellite signals are subsequently converted to corresponding video and audio signals that

1 can be output on a television 18 and/or a video cassette recorder 19 that are connected to
2 satellite broadcasting receiver 14.

3
4 With reference now to Figure 2, there is illustrated a conceptual block
5 diagram of satellite broadcasting receiver 14, in accordance with a preferred embodiment
6 of the present invention. As shown, satellite broadcasting receiver 14 includes a tuner 21,
7 a demodulator 22, an LNB controller 23, an LNB supply 24 and a PCB power supply 25
8 along with other devices 26. Tuner 21 amplifies and filters satellite signals received from
9 a directional receiver antenna. Demodulator 22 demodulates and decodes forward error
10 correction of the received satellite signals. LNB controller 23 generates and detects a 22
11 kHz pulse-width modulated signal in order to facilitate communications between satellite
12 broadcasting receiver 14 and an LNB feed, such as LNB feed 16 from Figure 1, attached
13 to the directional receiver antenna. LNB supply 24 supplies a variable voltage to power
14 the LNB feed attached to the directional receiver antenna.

15
16 With the exception of LNB supply 24, most of the above-mentioned
17 components within satellite broadcasting receiver 14 can be implemented within a
18 complementary-metal oxide semiconductor (CMOS) integrated circuit device that requires
19 less than 5 V of supply voltage. This is because LNB supply 24 must be capable of
20 driving voltages in the range of 13 V to 21 V, making integration of LNB supply 24 into
21 a low-voltage CMOS design prohibitive.

22
23 There are several prior art approaches for solving the above-mentioned LNB
24 supply integration problem. For example, a DC-DC converter can be used to implement
25 the LNB supply. Referring now to Figure 3, there is depicted a block diagram of an LNB
26 supply implemented by a DC-DC converter, according to the prior art. As shown, an LNB
27 supply 30 includes a voltage controller 31, a power transistor 32, a voltage selector 33, and
28 a voltage regulator 34. Voltage controller 31, power transistor 32, voltage selector 33, and
29 voltage regulator 34 are all implemented within a single integrated circuit device. LNB

1 supply 30 is coupled to external components 35 that provide a current sensing feedback to
2 voltage controller 31 within LNB supply 30. In addition, voltage regulator 34 provides a
3 voltage sensing feedback to voltage controller 31 within LNB supply 30.
4

5 The approach of implementing an integrated LNB supply with a DC-DC
6 converter, as depicted in Figure 3, is favorable from the standpoint that no additional
7 requirements is placed on the transformer for LNB supply 30. In addition, the DC-DC
8 converter can be designed to utilize an existing voltage rail on a receiver board. However,
9 the main drawback of implementing an integrated LNB supply with a DC-DC converter is
10 that low-voltage CMOS designs are not permissible. Hence, in the prior art, an LNB
11 supply within a satellite broadcasting receiver is typically implemented as a discrete device
12 separated from other devices within the satellite broadcasting receiver.
13

14 In accordance with a preferred embodiment of the present invention, a tuner,
15 a demodulator and a LNB controller and all functionalities of an LNB supply are integrated
16 into a single integrated circuit device, with the exception of a power transistor and a voltage
17 regulator.
18

19 With reference now to Figure 4, there is depicted a functional block diagram
20 of a receiving module of a satellite broadcasting receiver, in accordance with a preferred
21 embodiment of the present invention. As shown, a receiving module 40 includes a tuner
22 41, a demodulator 42, an LNB controller 43, a voltage controller 44 and a voltage selector
23 45. Preferably, receiving module 40 is implemented within a single monolithic integrated
24 circuit device manufactured under the CMOS technology.
25

26 As shown, receiving module 40 is coupled to a power transistor 46, a line
27 feed 47 and various external components 48. Specifically, voltage controller 44 is
28 connected to power transistor 46. Also, LNB controller 43 is connected to line feed 47.
29 In addition, a current sensor 51 provides a current sensing feedback from power transistor

1 46 to voltage controller 44. Similarly, a voltage sensor 52 provides a voltage sensing
2 feedback from line feed 47 to voltage controller 44.

3
4 During operation, tuner 41 amplifies and filters satellite signals that are
5 received from a directional receiver antenna. Demodulator 42 then demodulates and
6 decodes forward error correction of the received satellite signals. LNB controller 43
7 generates and detects a 22 kHz pulse-width modulated signal to facilitate communications
8 between receiving module 40 and an LNB feed (such as LNB feed 16 from Figure 1)
9 attached to a directional receiver antenna. Voltage controller 44 generates a control signal
10 to power transistor 46. Under the control of LNB controller 43, line feed 47 supplies a
11 variable voltage and a variable current to power the LNB feed attached to the directional
12 receiver antenna.

13
14 Referring now to Figure 5, there is depicted a circuit diagram of current
15 sensor 51 and voltage sensor 52, in accordance with a preferred embodiment of the present
16 invention. As shown, current sensor 51 includes a resistor R1 connected between power
17 transistor 46 and ground.

18
19 In addition to inductor L1, external components 48 also includes a diode D1
20 and a capacitor C1. The current from inductor L1 is sent to line feed 47 and power
21 transistor 46. The variable voltage sent to the LNB feed by line feed 47 is measured by
22 voltage sensor 52. Current sensor 52 includes two resistors R2 and R3 connected in series.
23 The output voltage of line feed 47 can be measured via the voltage divider formed by
24 resistors R2 and R3.

25
26 As has been described, the present invention provides an improved satellite
27 receiver for receiving digitally modulated broadcast signals from a satellite. The improved
28 satellite broadcasting receiver includes a tuner, a demodulator, an LNB controller, a voltage

1 controller and a voltage selector implemented within a single monolithic integrated circuit
2 device manufactured under the CMOS technology.

3
4 While the invention has been particularly shown and described with reference
5 to a preferred embodiment, it will be understood by those skilled in the art that various
6 changes in form and detail may be made therein without departing from the spirit and scope
7 of the invention.